

SPEC^{inc}

Learjet Participation in SEAC⁴RS



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SPEC

Roelof Brintjes - Duncan Axisa

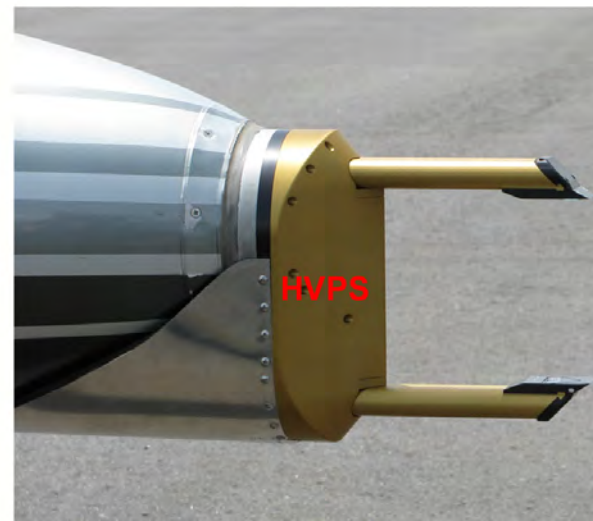
NCAR

SEAC⁴RS Science Meeting - 29 April 2013 - Boulder, CO

SPEC Learjet Performance in Research Configuration

Maximum Takeoff Weight	15,000 lbs
Maximum Certificated Ceiling	45,000 ft
Time to Climb Sea Level to 35,000 ft at Maximum T.O. Weight @ ISA	16 min
Maximum Duration (to fuel exhaustion)	3 hr
Maximum Airspeed	0.82 Mach (306 KIAS)
Number of Seats excluding pilots	4
Electrical Capability	(2) 400 A Generators @ 28.8 VDC = 23 KW Research Power = 7.2 KW distributed as 6.2 KW @ 110 VAC 60 Hz 1.0 KW @ 28 VDC

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100



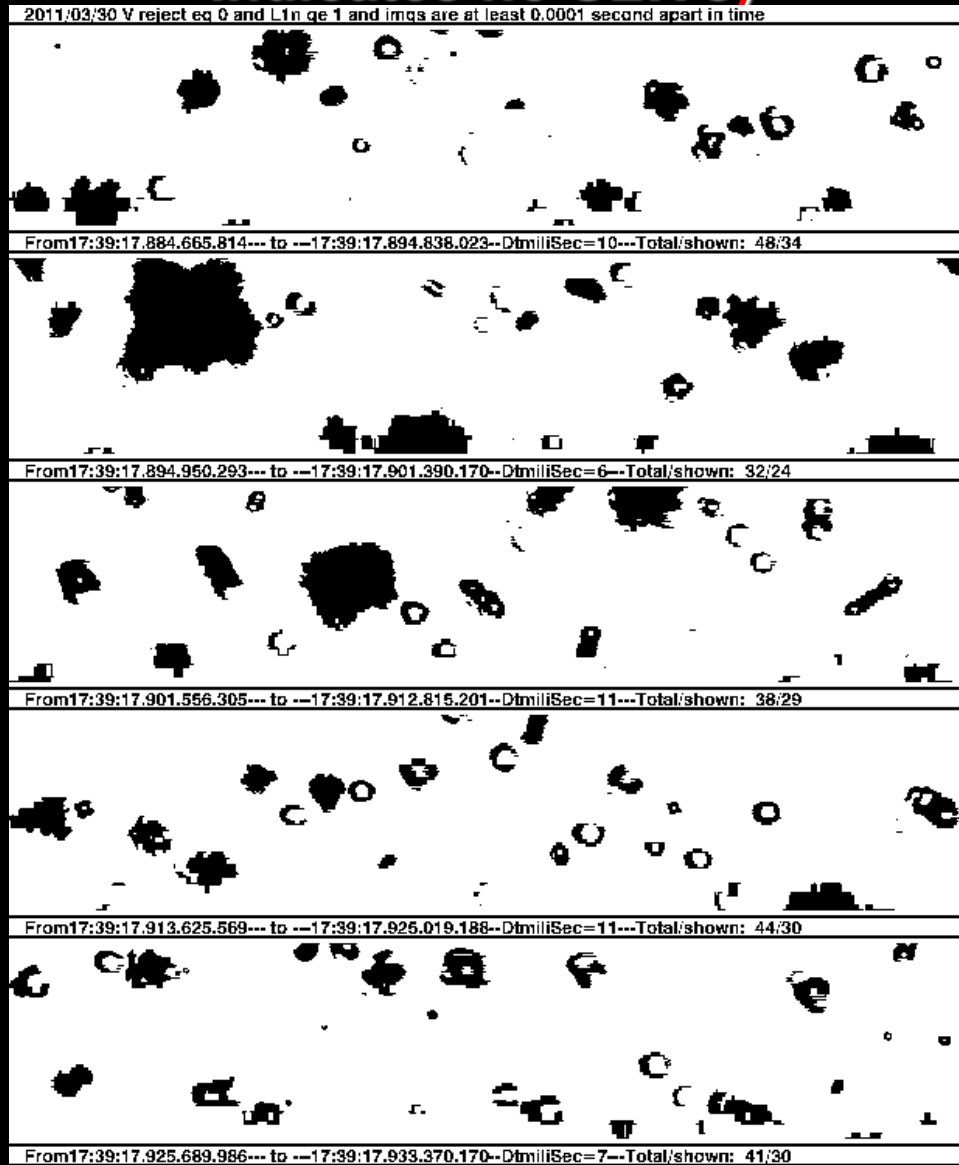
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<i>Equipment List</i>	<i>Manufacturer</i>	<i>Range</i>	<i>Accuracy</i>
Temperature	Rosemount Model 102 & 510BH	-50 to +50 °C	0.5 °C
Altitude	Royal Air FAA RVSM Certification	45,000 ft (13.7 km)	60 ft (18.3 m)
Airspeed	Royal Air FAA RVSM Certification	0 to 220 m s ⁻¹	1 m s ⁻¹
Dew Point Temperature	EdgeTech Chilled Mirror C-137	-50 to + 50°C	1°C
Cloud Liquid Water/Total Water (2)	Sky Tech Nevzorov LWC/TWC	0 to 4 g m ⁻³	0.1 g m ⁻³
Icing Rate	Rosemount Icing Rod 871LM5	N/A	Sensitivity ~0.01 g m ⁻³
Aircraft Position	Aventech AIMMS-20 Dual GPS	N/A	10 m
Aircraft Heading	Learjet Sperry Directional Gyro	0 to 360°	1°
Horizontal Wind	Aventech AIMMS - 20	0 to 360° 1 to 100 m s ⁻¹	1° 1 m s ⁻¹
Vertical Wind	Aventech AIMMS - 20	0 to 50 m s ⁻¹	0.5 m s ⁻¹
2D-S (Stereo) Optical Array Spectrometer	SPEC Model OAP 2D-S	10 µm to 3 mm	10 µm
Fast Cloud Droplet Probe (FCDP)	SPEC Model FCDP-100	2 to 50 µm	2 µm
Fast Forward Scattering Spectrometer Probe (FFSSP)	SPEC Model FFSSP-100	2 to 50 µm	2 µm
High Volume Precipitation Spectrometer (HVPS)	SPEC Version-3 HVPS	150 µm to 2 cm	150 µm
Combination FCDP, 10 and 50 µm 2D-S, V 2.5 CPI	SPEC Hawkeye	1 µm to 6,400 µm	1 µm FCDP 10-50 µm 2D-S 2.3 µm CPI
Passive Cavity Aerosol Spectrometer (PCASP)	PMS	0.1 to 3 µm	0.05 µm
Nucleation Mode Aerosol Size Spectrometer (NMASS)	DU	4 nm to 0.1 µm	5 selectable size bins
CCN Counter	DMT CCN-100	SS 0.07% to 1 %	N/A

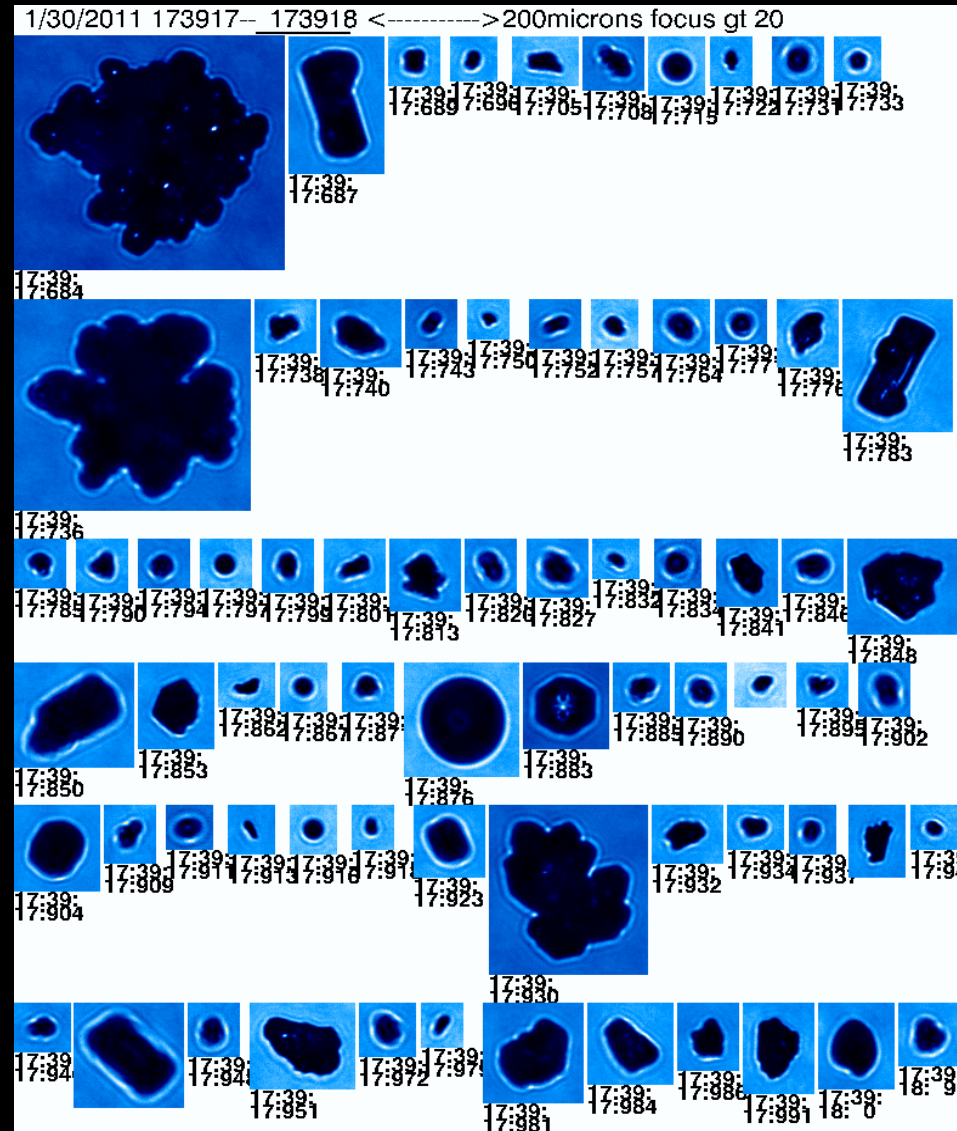
Measurements In Convection

- **Lear to Collect Air Motion, State Parameter, Aerosol and CCN Measurements at Cloud Base.**
- **Climb Rapidly with Ascending Updraft and Collect Microphysical Data from Cloud Base to -37°C .**
- **Suite of Cloud Particle Probes Measure Size Distribution from $1\text{ }\mu\text{m}$ to several cm.**
- **Cloud Particle Imager (CPI) used to Distinguish Water Drops and Ice Particles in Growing Cumulus, and to Automatically Identify Ice Particle Habit in Anvils and Cirrus.**

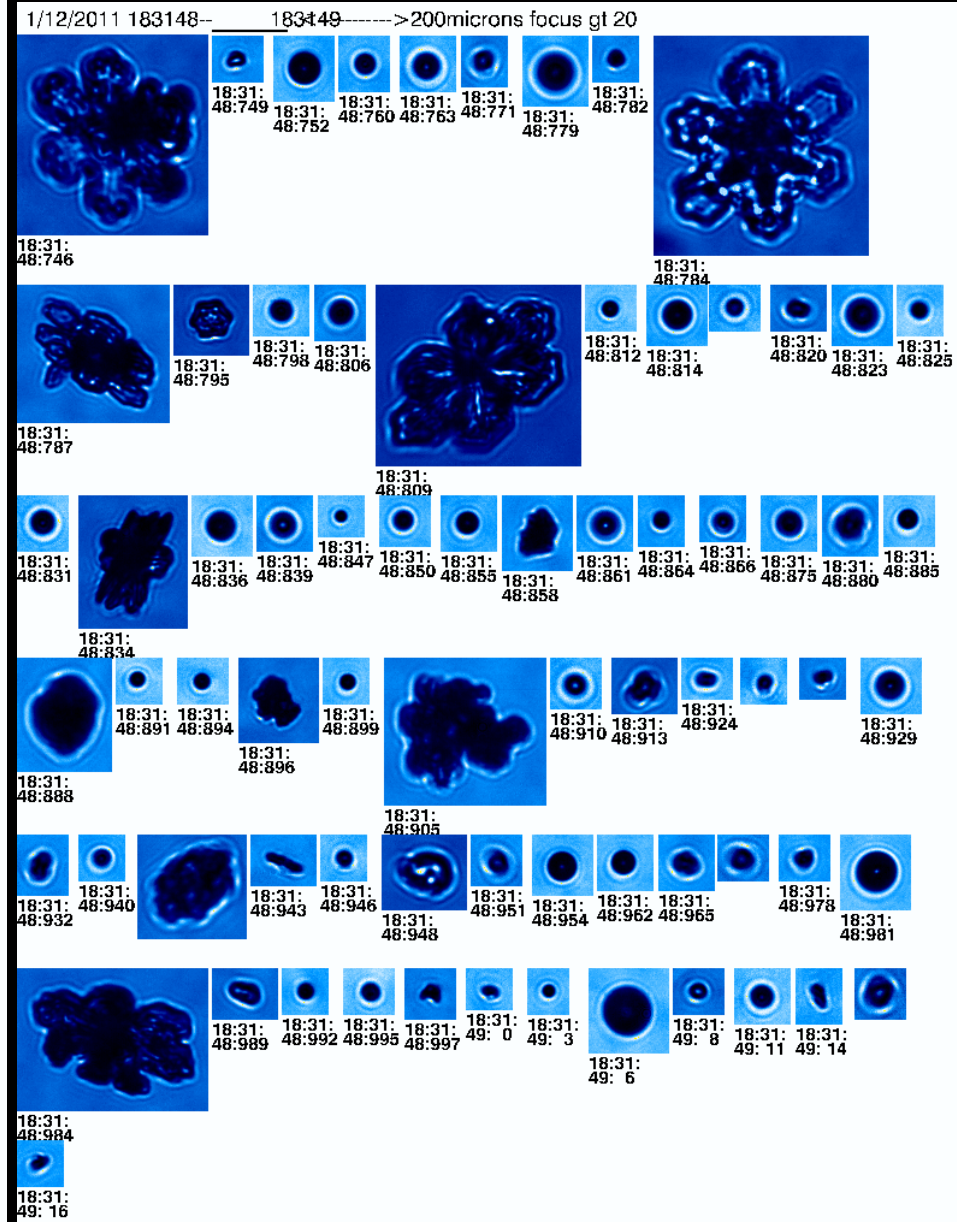
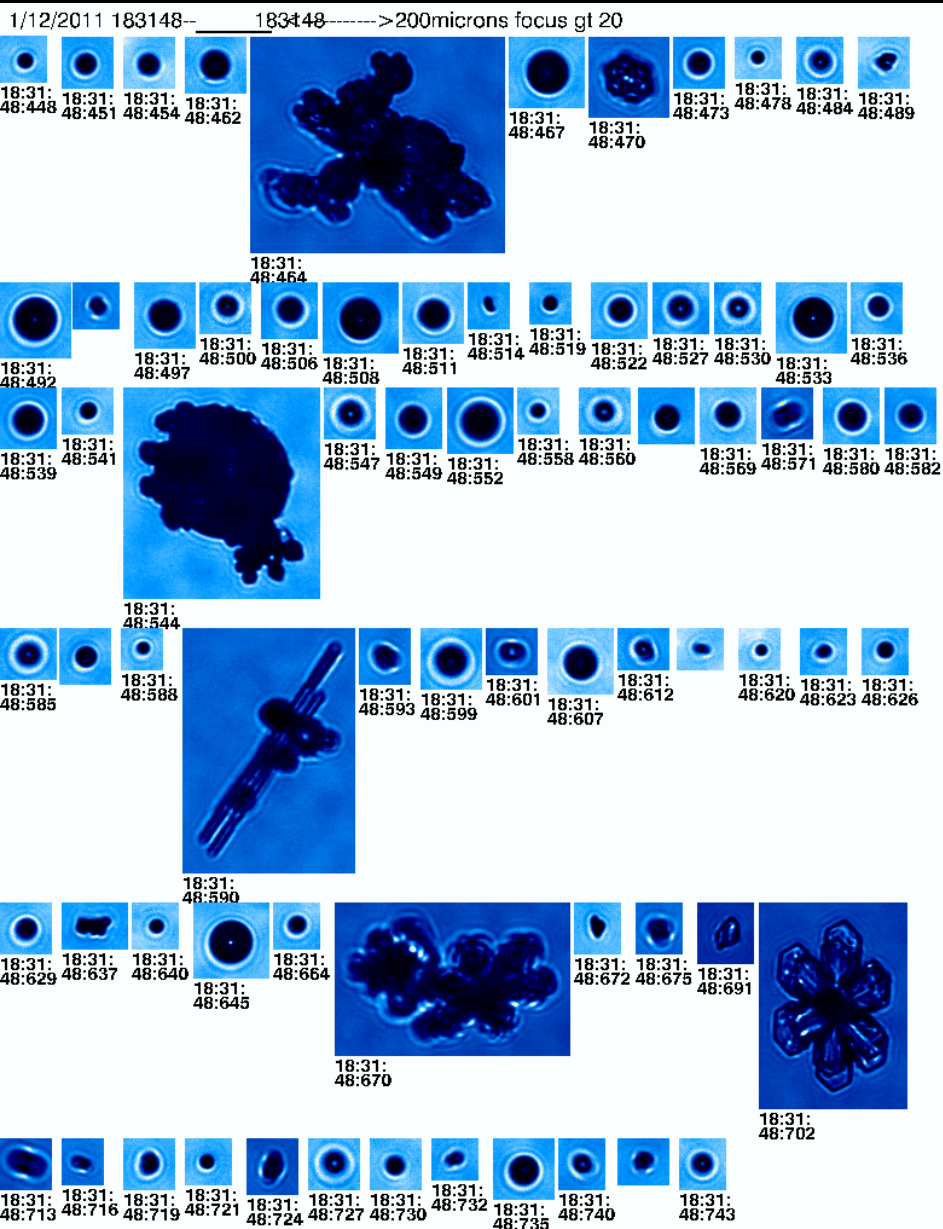
2D-S Images in a Decaying ICE-T Turret @ -24°C Appear to be All Ice (Rosemount icing Probe Indicates no SLWC)



CPI Images at Same Time Show Low Concentration of Supercooled Drops

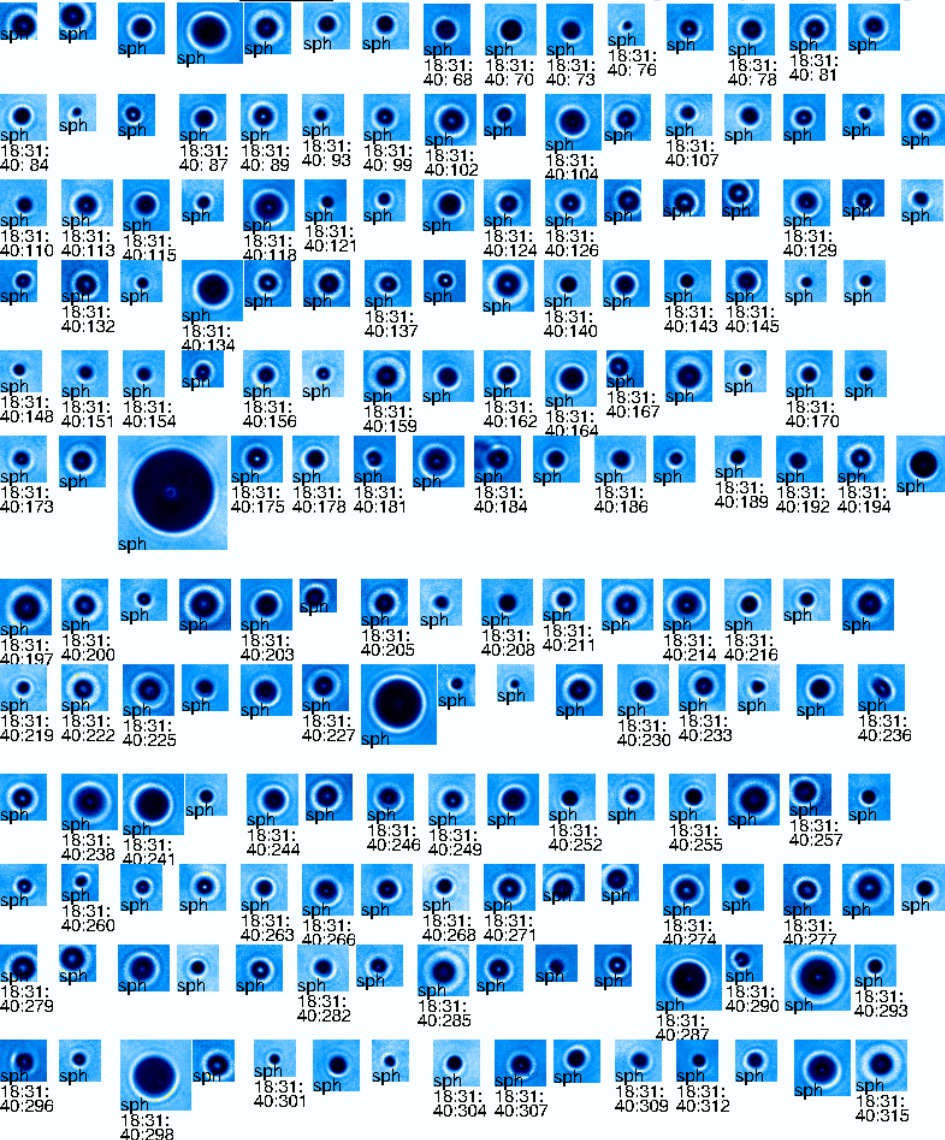


Examples of CPI Images in Mixed-Phase at -17 C

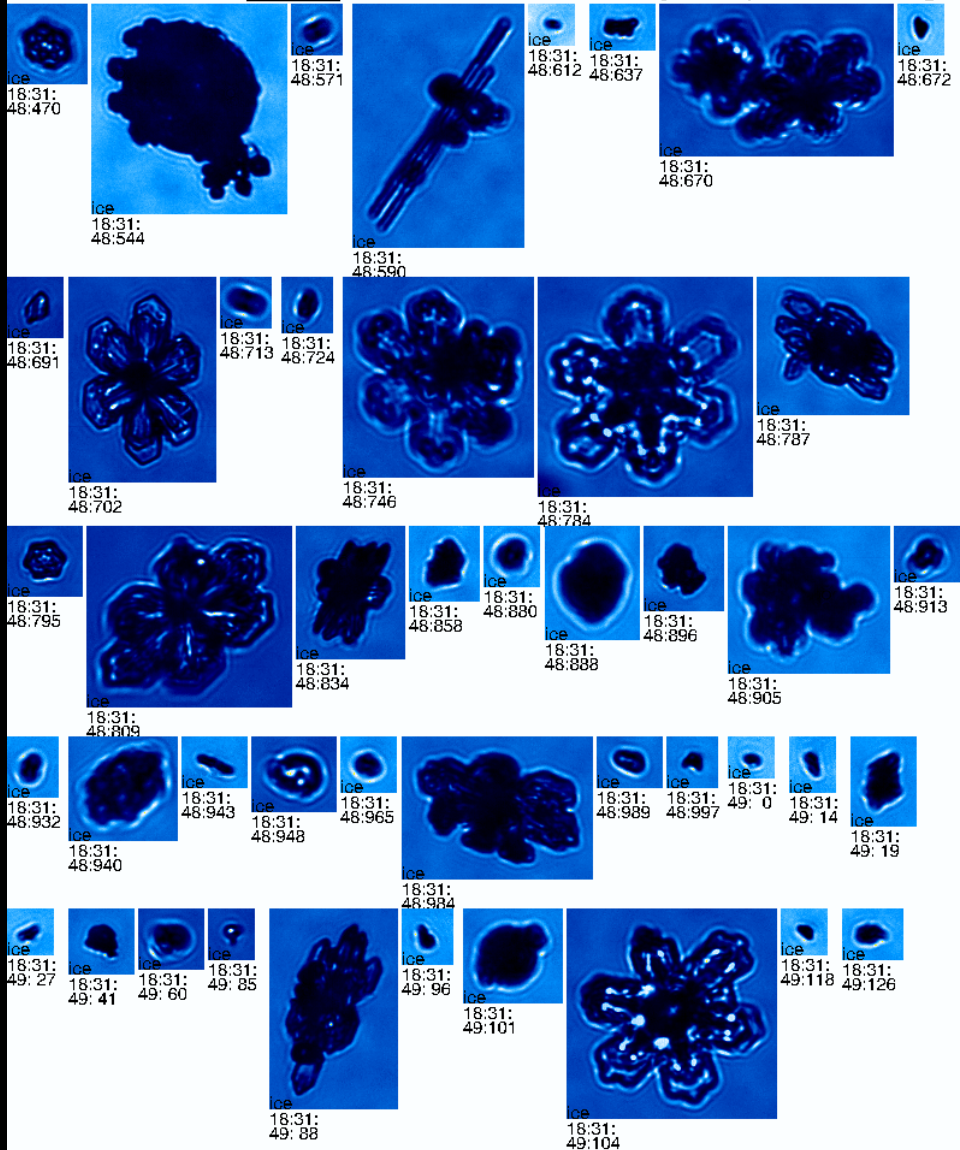


CPI Images in Mixed-Phase Automatically Separated into: Water and Ice

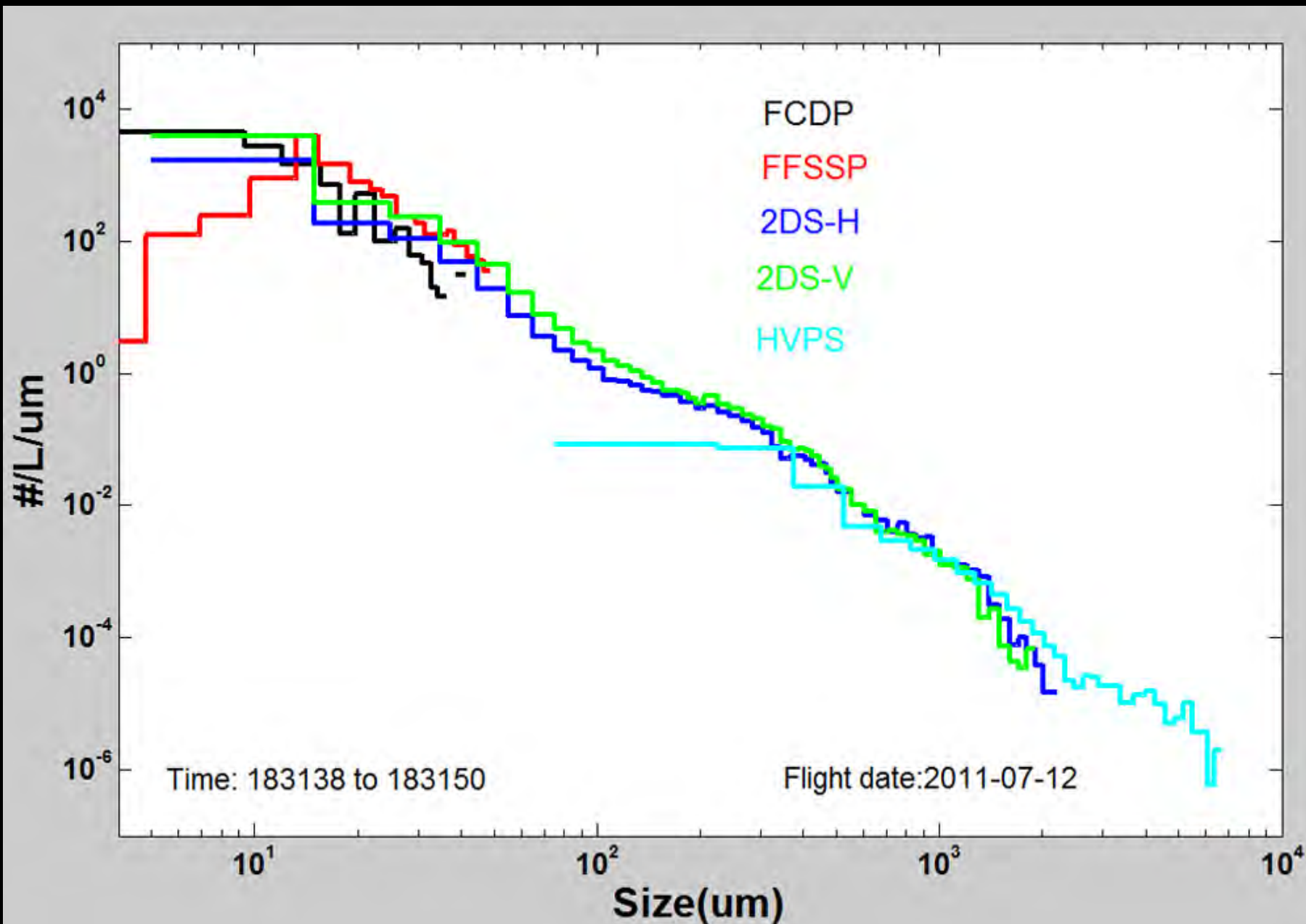
7/12/2011 183140-- 183140 <-----> 200microns crystal eq 1 and focus gt 20



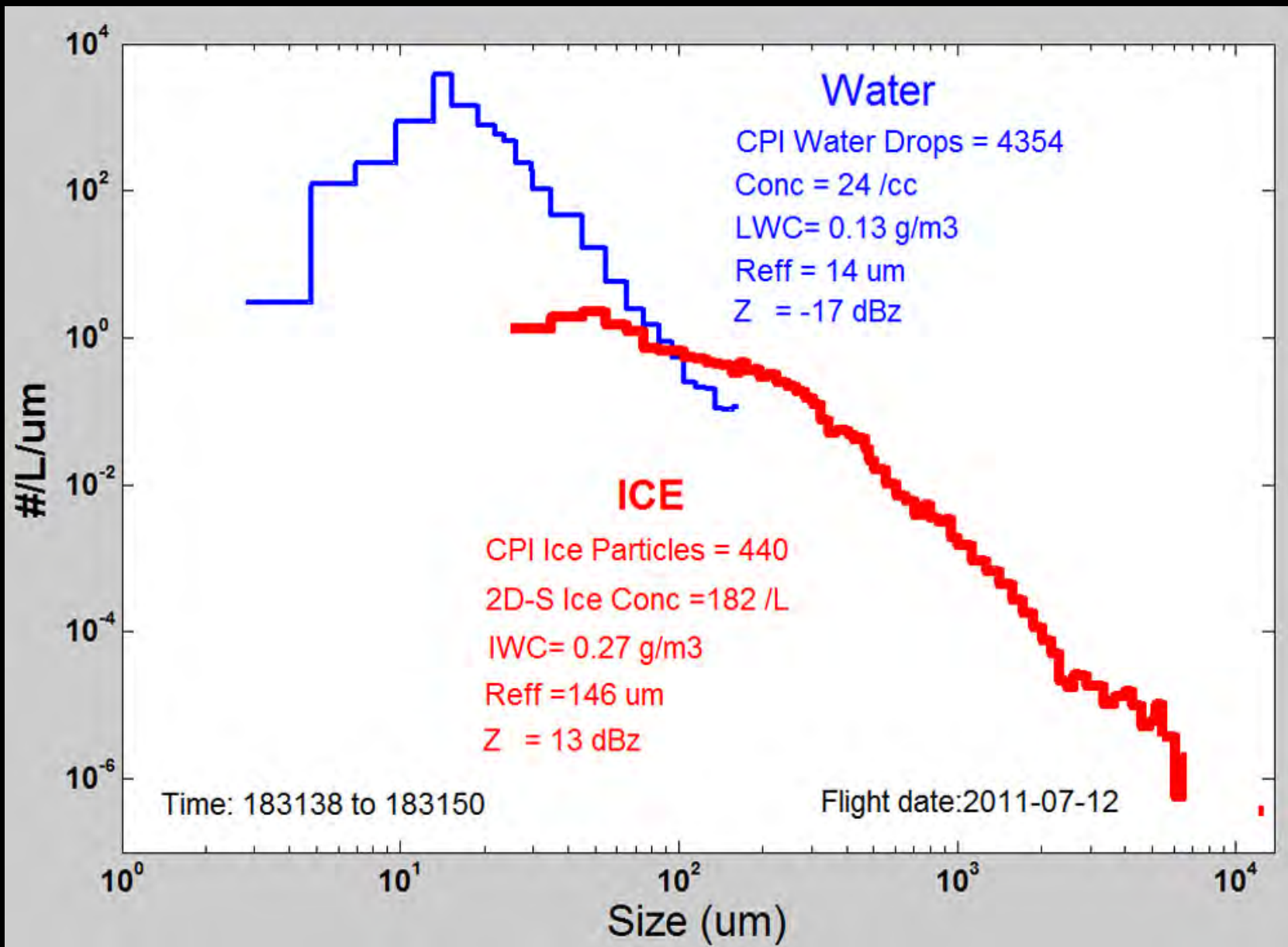
7/12/2011 183148-- 183149 <-----> 200microns crystal eq 15 and focus gt 20



Particle Size Distributions from Various Probes

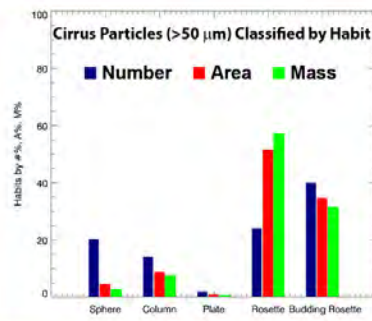
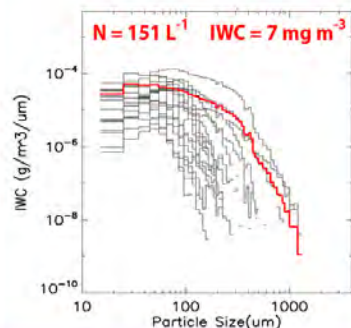


Using CPI Automatic Image Recognition to Generate FFSSP, 2D-S, HVPS Water and Ice Size Distributions in Mixed-Phase

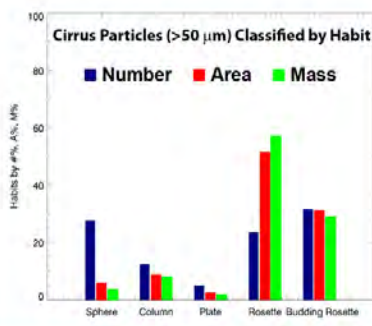
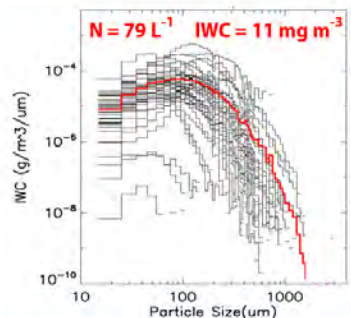


Example of Measurements In SPARTICUS Cirrus and Anvils

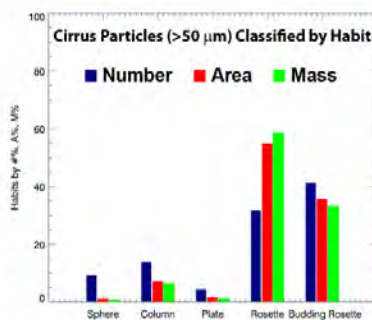
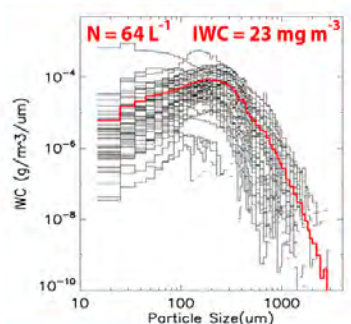
205-215 K



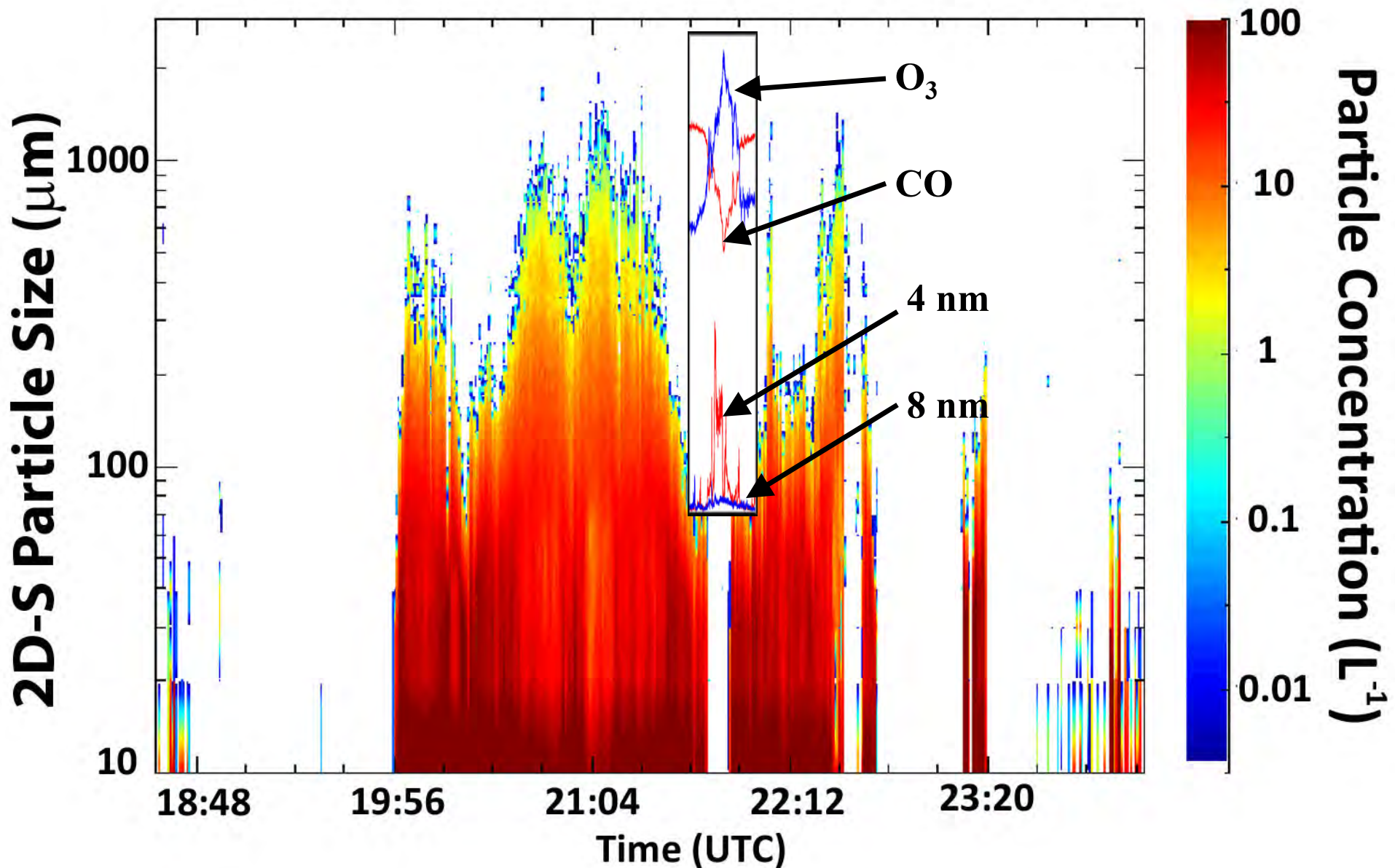
215-225 K



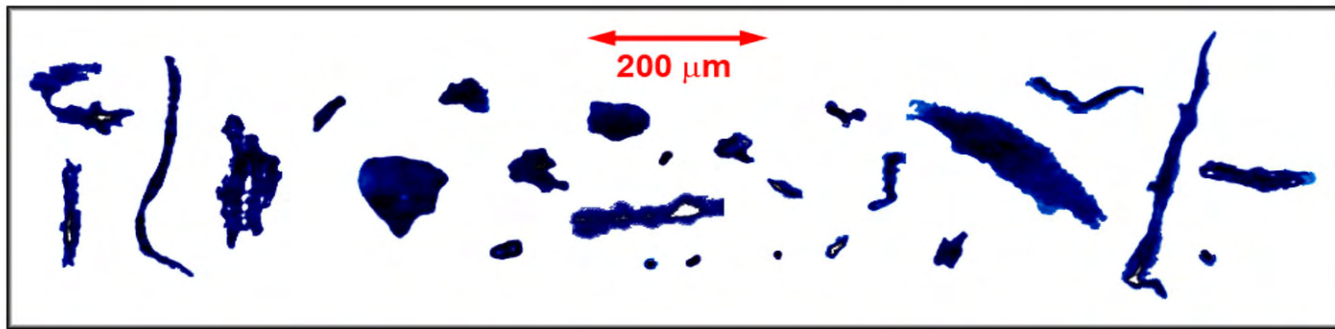
225-235 K



Example of Aerosol Activation: WB-57 in MACPEX Anvil



Example of CPI Images in Smoke



CPI Smoke Images Collected in Wyoming by the NSF/NCAR C-130



Measurements in Pyrocumulus?



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SUMMARY

- Learjet capable of rapid (6,000 fpm @ Sea Level) climb to measure aerosol and CCN at cloud base, then ascend with a convective updraft and document the development of cloud drop and ice particle formation.
- State-of-the-art cloud particle probes will collect ice particle size and shape data in Cirrus and Anvils.
- PCASP and NMASS will document new aerosol nucleation in Anvils.
- Collect CPI images of smoke from forest fires.
- First-time measurements in Pyrocumulus?